Origins of the S-type Cape Granites (South Africa)

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Abstract:

The Pan-African Cape Granite (CG) Suite, South Africa, consists of S- (~ 560 – 540 Ma), I- (~ 540 – 515 Ma) and A-type (~ 515 – 510 Ma) plutons and extrusive rocks. They intruded the low-grade (greenschist-facies) Malmesbury Supergroup (~ 750 – 610 Ma) during and after the Saldanian orogeny (~ 580 – 545 Ma). The syn- to late-tectonic S-type CG vary in composition from granodioritic to leucogranitic and contain biotite, cordierite and occasionally garnet. These granites host fine-grained granitic enclaves, metasedimentary xenoliths (predominantly amphibolite-facies) and rare metamafic xenoliths.

The Sm-Nd and Rb-Sr geochemistry of the S-type granites indicates that all have a purely crustal origin. The narrow range of Nd-isotope compositions ($\varepsilon_{Nd\ (550Ma)}$ = -4.0 to -4.7) matches those of the Malmesbury Group and the metasedimentary xenoliths ($\varepsilon_{Nd\ (550Ma)}$ = -4.3 to -10.2; mostly -4.3 to -5.1) this suggests that the Malmesbury Group is the source of S-type CGs. The ε_{Nd} values of the magmatic enclaves are typically very similar to those of the granites (-4 to -5), although some with ε_{Nd} as high as -2.3 at 550 Ma, possibly indicate a second source.

Thermobarometry using the mineral assemblage (Cpx-Amp–Pl–Bt–Qtz) from a metamafic xenolith result in a peak *P-T* estimate of 10 ± 1 kb and 850 ± 50 °C. This is interpreted to reflect the metamorphic conditions in the magma source region. Similarly, the highest grade, but non-restitic, metasedimentary xenoliths (Grt–Bt–Pl–Qtz) result in *P-T* estimates of ~ 750 °C and ~ 7 kb, possibly representing conditions in the metamorphic terrain overlying the melting zone. Zoned garnet within the plutons varies in composition from ~ $Alm_{70}Pyr_{25}Grs_2Sps_3$ in the interiors to rim overgrowths of $Alm_{70}Pyr_{10}Grs_2Sps_{18}$. Both differ from the $Alm_{60}Pyr_{15}Grs_{15}Sps_{10}$ garnet cores in the metasedimentary xenoliths. The two garnet generations in the granites are interpreted to record different stages of the *P-T* evolution of the magma. Modelling of the phase stabilities in these compositions suggests that the cores record pressures of 5 to 7 kb (at ~750 °C), while the rims formed at 3 to 4 kb and a temperature close to the solidus (~ 650 °C).

Collectively, these results suggest that the S-type CG magmas resulted solely from biotite fluid-absent partial melting of tectonically thickened (≥ 35 km) Malmesbury Group like metasediments along a convergent continental margin